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providing as an adding element to said first or second capacitor electrode at least one element selected from the group consisting of nickel and titanium. --

REMARKS

Reconsideration and allowance of this application, as amended, is respectfully requested.

This amendment is in response to the Office Action dated March 27, 2002. Appreciation is expressed to the Examiner for the allowance of claims 3-5. By the present amendment, clarifying amendments have been made to claims 1, 2, 14 and 16, and new claim 17 has been added to define the invention from the different perspective.

Briefly, the present invention is directed to providing a capacitor which has improved adhesiveness between a capacitor between a capacitor electrode film and an insulating film used in forming the capacitor.

As discussed the background of the invention on pages 1-3, efforts have been made in recent years to provide improved materials both for insulating films and electrode films for capacitors in semiconductor devices. In particular, with regard to capacitor electrode materials, as discussed on page 2, lines 19 et seq., capacitor electrode materials with noble metals such as rhodium (Rh), ruthenium (Ru), iridium (Ir), osmium (Os), and platinum (Pt), etc., have the desirable feature of hardly being oxidized at high temperature. This serves to prevent an oxidation reaction taking place at the contact interface between the electrode and the oxide film at high temperatures which can deteriorate the properties of the oxide film (e.g., see page 2, line 14 et seq.). On the other hand, as discussed on page 3, line 7 et seq., such noble metals have a problem of poor adhesion to silicon oxide which is typically used as an insulating film. Accordingly, the present invention is directed to resolving this

adhesion problem to render the use of such noble materials more desirable for forming capacitor electrodes.

To this end, as discussed on page 35, lines 19-27, titanium and nickel provide excellent adding elements for electrodes made of noble metals. As specifically set forth on page 35, line 21 et seq.:

“That is, in order to improve the adhesiveness, titanium is the most effective, and when heat treatment is conducted in an oxygen atmosphere, the most excellent adding element in electrical stability is nickel. From these results, it is more preferable to use titanium or nickel as the adding element.”

Reconsideration and allowance of claims 1, 2, 6, and 14-16 over the 35 U.S.C. 103 rejection based on Marsh (USP 6,323,511) in view of Schuele (USP 5,760,474) and the article to Wolf is respectfully requested. By the present amendment, claims 1, 2 and 14 have been amended to delete the recitations of the adding material including palladium and cobalt. As such, claims 1, 2 and 14 are now specifically directed to selecting an adding element from a group consisting of nickel and titanium. As noted above regarding page 35, applicants have found nickel and titanium to be particularly excellent for purposes of an adding element to improve adhesiveness of the electrode to the insulating film. Neither the primary reference to Marsh nor the secondary references to Schuele and Wolf et al. suggest an adding element selected from a group consisting of nickel and titanium. As such, these references fail to recognize the particular excellence of nickel and titanium for fulfilling the purposes of the present invention of improving adhesiveness of the capacitor electrode to the insulating film. Therefore, reconsideration and allowance of claims 1, 2, 6 and 14 over the cited prior art is respectfully requested.

Reconsideration and allowance of amended claim 16 over the cited prior art is also respectfully requested. By the present amendment, claim 16 has been

amended to specifically define that the electrode material includes a region containing an electrode selected from the group consisting of palladium, nickel, cobalt and titanium "in a concentration of more than about 15 atom %." This concentration is neither taught nor suggested in the cited prior art for the materials defined in claim 16. As set forth on page 21, lines 1 et seq.:

"When the concentration of the adding element becomes more than about 15 atom %, almost constant adhesive fracture energy is obtained to mean that the effect for improving adhesiveness is saturated."

In other words, applicants have recognized that providing a concentration of the recited adding elements of more than about 15 atom % is an optimized amount for improving adhesiveness. Nothing in the cited prior art teaches or suggests this. Accordingly, reconsideration and allowance of amendment claim 16 is also respectfully requested.

Consideration and allowance of claim 15 is also respectfully requested. In the Office Action, it is stated on page 4 of the Office Action that Marsh discloses a titanium fill 75 between a first capacitor electrode 85 and an interlayer insulating film 40. However, a closer inspection of Fig. 2 of Marsh indicates that both the first capacitor electrode 85 and the interlayer insulating film 40 are positioned in a neighboring relationship to the titanium film 40. As such, it is respectfully submitted that Marsh fails to teach or suggest the claims relationships set forth in claim 15, whether considered alone or in combination with the secondary references to Schuele and Wolf. Therefore, reconsideration and allowance of claim 15 is also respectfully requested.

Finally, consideration and allowance of newly presented claim 17 is also respectfully requested. This claim contains the limitations similar to those set forth in

claim 17, but defines the adding element in terms of "means for enhancing adhesiveness of said first or said second capacitor electrode to said insulating film to prevent peeling." As such, claim 17 defines a function for the adding element in terms of "means plus function" which is not remotely suggested by either the primary reference to Marsh or the secondary references to Schuele and Wolf. Therefore, consideration and allowance of newly presented claim 17 is also respectfully requested.

Attached hereto is a marked-up version of the changes made to the claims by the current amendment. The attached page is captioned "Version with markings to show changes made."

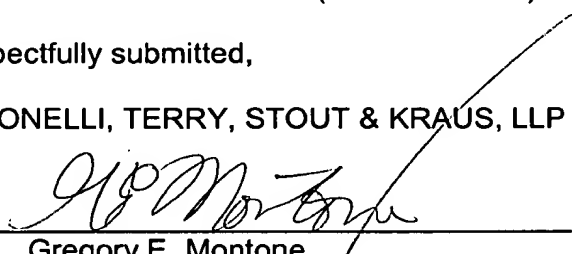
If the Examiner believes that there are any other points which may be clarified or otherwise disposed of, either by telephone discussion or by personal interview, the Examiner is invited to contact applicants' undersigned attorney at the number indicated below.

To the extent necessary, the applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in the fees due in connection with the filing of this paper, including extension of time fees, to the deposit account of Antonelli, Terry, Stout & Kraus, Deposit Account No. 01-2135 (501.39830X00).

Respectfully submitted,

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By



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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Claims 1, 2, 14 and 16 have been amended as follows:

1. (Amended) A semiconductor device equipped with a capacitor for storing information comprising a substrate, a first capacitor electrode formed on the substrate, an oxide film formed in contact with the first capacitor electrode, a second capacitor electrode formed in contact with the oxide film, and an insulating film containing silicon as a main constituting element and formed in contact with the first capacitor electrode and second capacitor electrode, said first capacitor electrode or said second capacitor electrode containing as a main constituting element at least one element selected from the group consisting of rhodium, ruthenium, iridium, osmium, and platinum, and as an adding element at least one element selected from the group consisting of [palladium,] nickel[, cobalt,] and titanium.

2. (Amended) A semiconductor device equipped with a capacitor for storing information comprising a substrate, a first capacitor electrode formed on the substrate, an oxide film formed in contact with the first capacitor electrode, a second capacitor electrode formed in contact with the oxide film, and an insulating film containing silicon as a main constituting element and formed in contact with the first capacitor electrode and second capacitor electrode, said first capacitor electrode or said second capacitor electrode containing as a main constituting element ruthenium, and as an adding element at least one element selected from the group consisting of [palladium,] nickel[, cobalt,] and titanium.

14. (Amended) A process for producing a semiconductor device equipped with a capacitor for storing information comprising a substrate, a first capacitor electrode formed on the substrate, an oxide film for a dielectric formed in contact with the first capacitor electrode, a second capacitor electrode formed in contact with

the oxide film, and an insulating film containing silicon as a main constituting element and formed in contact with the first capacitor electrode and second capacitor electrode, which comprises forming at least one of the first capacitor electrode and the second capacitor electrode by using

(a) at least one element selected from the group consisting of rhodium, ruthenium, iridium, osmium and platinum as a main constituting element, or

(b) at least one material selected from the group consisting of ruthenium oxide and iridium oxide as a main constituting material, and at least one element selected from the group consisting of [palladium,] nickel[, cobalt,] and titanium as an adding element.

16. (Amended) A semiconductor device equipped with a capacitor for storing information comprising:

a first capacitor electrode;

a second capacitor electrode;

an oxide film; and

an insulating film, said insulating film being formed outside of said first capacitor electrode or said second capacitor electrode,

wherein said first capacitor electrode or said second capacitor electrode contain as a main constituting element at least one element selected from the group consisting of rhodium, ruthenium, iridium, osmium, and platinum, and, near the boundary of said insulating film, said first capacitor electrode or said second capacitor electrode includes a region containing an element selected from the group consisting of palladium, nickel, cobalt, and titanium in a concentration of more than about 15 atom %.

New claim 17 has been added.